UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

A RECONNAISSANCE GEOCHEMICAL SURVEY OF THE ALLEGHENY FRONT AND HICKORY CREEK ROADLESS AREAS, ALLEGHENY NATIONAL FOREST, WARREN COUNTY, PENNSYLVANIA

By

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This report has not been reviewed
for conformity with U.S. Geological Survey
editorial standards or
stratigraphic nomenclature

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CONTENTS

ILLUSTRATIONS

TABLES

Tables (continued)

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geochemical survey of the Allegheny Front and Hickory Creek Roadless Areas (fig. 1), Allegheny National Forest, Warren County, Pennsylvania. The areas were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January, 1979.

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ABSTRACT

A reconnaissance geochemical survey of the Allegheny Front and Hickory Creek Roadless Areas, Warren County, Pennsylvania, was made by members of the U.S. Geological Survey (USGS) to test for indistinct or unexposed mineral deposits that might be recognized by geochemical halos.

Analyses using semiquantitative emission spectrography and atomic absorption for 32 elements were performed on 21 stream-sediment samples and 31 bedrock samples from the Allegheny Front tract, and on 23 stream-sediment samples and 6 bedrock samples from the Hickory Creek tract. Bedrock samples analyzed are primarily sandstone, siltstone and shale.

Neither major chemical anomalies nor obviously anomalous chemical-element concentrations related to mineralized bedrock were indicated in the geochemical survey. Metallic mineral deposits were not identified in the study area during the survey, which is consistent with other studies reported in the literature for the surrounding region. The lithologic units exposed in the roadless areas do not commonly host metallic deposits in the surrounding region, and the probability is low that such deposits occur in the roadless areas.

Introduction

The analyses presented in this report are on samples from the Allegheny Front and Hickory Creek Roadless Areas, hereinafter called the study areas (fig. 1), Allegheny National Forest, Warren County, Pennsylvania. The samples, collected by N.L. Hickling and S.P. Schweinfurth in October 1980, consist of 21 stream-sediment and 31 bedrock samples from the Allegheny Front tract and 23 stream-sediment and 6 bedrock samples from the Hickory Creek tract (Plate 1). The samples were collected in conjunction with geologic field investigations in the roadless areas (Schweinfurth and others, 1982a). Most of the bedrock samples, described briefly below, are composites of chip samples of the freshest material available at the outcrops. Stream-sediment samples are composites of several handfuls of the fine sediment at each sediment sample locality shown in Plate 1. The samples were analyzed by the USGS in Denver, Colorado.

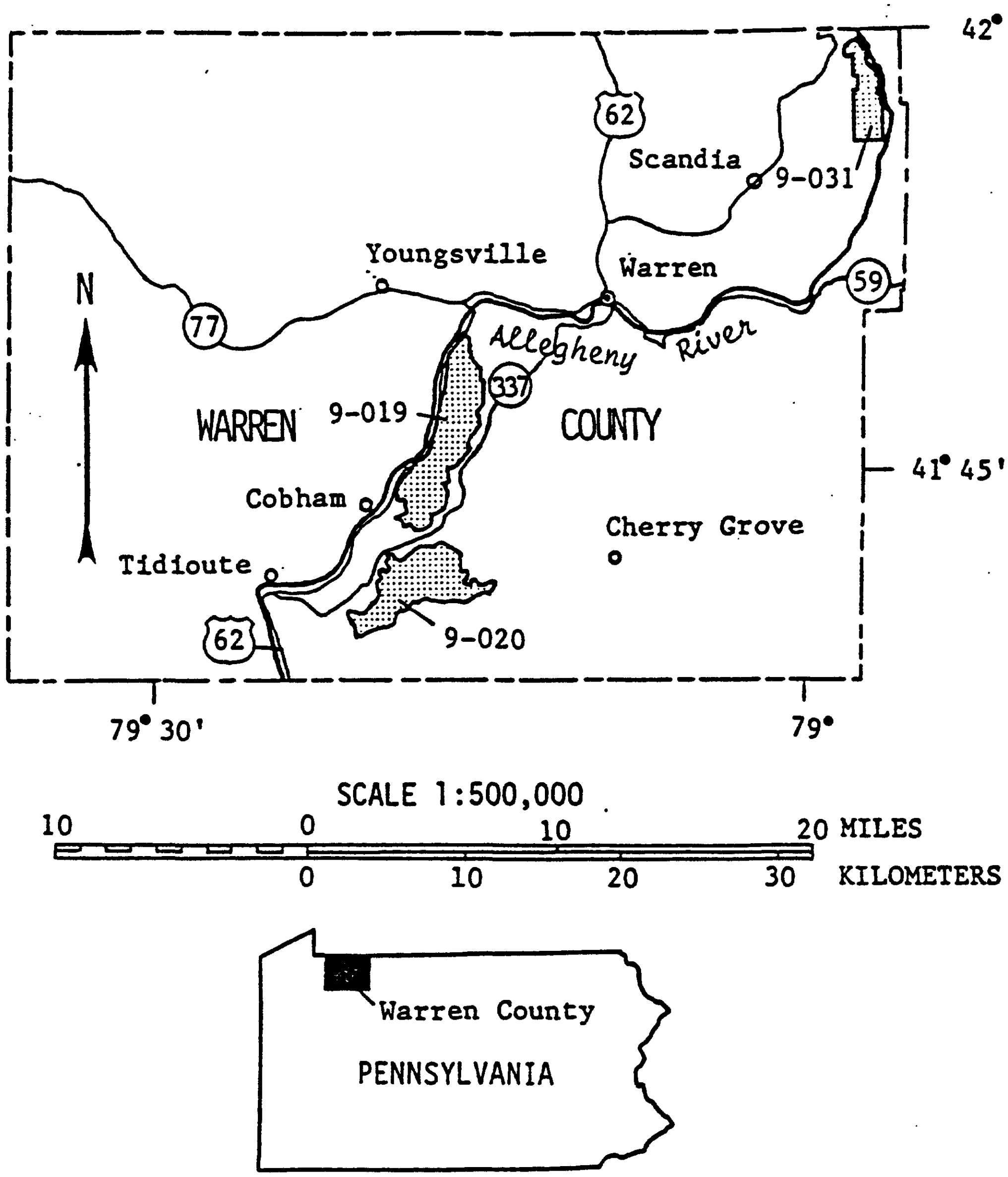

Figure 1.--Index map showing Allegheny Front (9-019), Hickory Creek (9-020), and Cornplanter (9-031), Roadless Areas, Allegheny National Forest, Warren County, Pennsylvania. Individual tracts (shaded) are designated by their Forest Service numbers. (The Cornplanter Area is covered in a report by Lesure, 1983.)

Analytical Techniques

Bedrock samples were crushed to approximately 0.25-in. (6 mm) particle size, and pulverized to minus 140-mesh (0.105 mm) by ceramic plates in a vertical grinder. Stream sediments were dried, sieved and the minus 80-mesh (0.177 mm) fraction was used for the analyses.

Each sample was analyzed semiquantitatively for 31 elements by Betty M. Adrian, Bernie Zickmund, Gretchen Nelson, and Dean McCullum, USGS., using a six-step, direct-current-arc, optical-emission spectrographic method (Grimes and Marranzino, 1968). In addition, each sample was analyzed by Robert Fairfield, USGS, for zinc, by means of an atomic-absorption technique (Ward and others, 1969, p. 20), and scanned for uranium (none detected), by a fluorometric method (modified from Centanni and others, 1956). The semi-quantitative spectrographic values are reported as six steps per order of magnitude (1, 1.5, 2, 3, 5, 7, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. The precision is shown to be within one adjoining reporting interval on each side of the reported value 83 percent of the time and within two adjoining intervals 96 percent of the time (Motooka and Grimes, 1976).

Discussion of Results

Summaries of the analytical data obtained from the samples are presented in tables 1 and 2. The detailed analytical data for each sample summarized in table 1 are listed in tables 3 and 4, and those summarized in table 2 are listed in tables 5 and 6.

Table 1 is a summary of the results of the analyses of stream-sediment samples (columns 1 and 2) and includes a summary of the analytical results for samples collected in the Clarion River Roadless Area (column 3) for comparison. The Clarion River Roadless Area lies about 35 mi to the southeast of the areas discussed in this report and is covered in separate reports (Hickling and others, 1983; Schweinfurth and others, 1982b). However, the geochemical data for the Clarion River area are included here because the area is within the National Forest and because there are enough similarities in the geology of the two areas to make the comparison of interest. For comparison, table 1 also includes in column 4 a summary of data on the elemental composition of surficial materials in the conterminous U.S. (Shacklette and others, 1971).

The data on the elemental composition of surficial materials in column 4 of table 1 are the high and low values for elements in soils and other surficial materials. The values given are the points at the limits of two geometric deviations on either side of the geometric means of the elemental compositions. These ranges include about 95 percent of the values for each element (Shacklette and others, 1971, p. D5). The elemental compositions reported in column 4 were obtained by semiquantitative spectrographic methods, except for zinc which was analyzed by the colorimetric method (Shacklette and others, 1971, table 2).

Table 1. Range and median values for 23 elements in stream-sediment samples from in and near the Allegheny Front and Hickory Creek Roadless Areas, Warren County, Pennsylvania and the Clarion River Roadless Area, Elk County, Pennsylvania. All analyses are by semiquantitative spectrographic methods by B.M. Adrian, B. Zickmund, G. Nelson and D. McCullum, except zinc which are by atomic absorption by R. Fairfield. Spectrographic analyses are reported as six steps per order of magnitude (1, 1.5, 2, 3, 5, 7, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. The precision is shown to be within one adjoining interval on each side of the reported value 83 percent of the time and within two adjoining intervals on each side of the reported value 96 percent of the time (Motooka and Grimes, 1976). Letter symbols: L, detected but below limit of determination (value shown in parenthesis after element symbol); N, not detected; >, greater than. Elements analyzed for specrographically but not detected and their lower limits of detection: As(200), Au(10), Bi(10), Cd(20), Mo(5), Sb(100), Th(100), and W(50).

	1 ALLEGHENY FRONT STREAM SEDIMENT 21 SAMPLES			2 HICKORY CREEK STREAM SEDIMENT 23 SAMPLES			3 CLARION RIVER a/ STREAM SEDIMENT 9 SAMPLES			4 ELEMENTAL COMP. b/ SURFICIAL MATERIALS CONTERMINOUS U.S.	
Elements	LOW	HIGH	MEDIAN	LOW	HIGH	MEDIAN	LOW	HIGH	MEDIAN	LOW c/	HIGH c/
						PERCENT					
Ca(0.05)	0.05	0.2	0.07	L	0.1	0.05	L	0.1	0.05	0.06	13.5
Fe(0.05)	1.5	5	3	1.5	5	2	1	5	3	0.3	9.5
Mg(0.02)	0.2	0.7	0.3	0.1	0.5	0.2	0.1	0.3	0.2	0.05	4.8
Ti(0.002)	0.5	0.7	0.7	0.3	0.5	0.5	0.5	1	0.7	0.07	0.87
						PARTS PER MILLION					
Ag(0.5)	N	0.7	N	N	N	N	N	N	N	na	na
B(10)	70	150	100	50	150	100	50	150	100	6.2	109
Ba(20)	300	1000	700	200	500	300	300	1000	700	101	1825
Be(1)	1	5	1.5	1	2	1.5	1	2	1.5	0.1	3.7
Co(5)	10	30	15	7	20	15	15	30	15	1.4	34.2
Cr(10)	70	200	100	50	150	70	70	150	100	6.9	199
Cu(5)	10	30	20	7	20	15	10	30	20	3.5	93.6
La(20)	N	70	N	N	50	N	N	100	N	9.9	116
Mn(10)	1500	5000	2000	200	3000	1000	1500	5000	5000	46.6	2478
Nb(20)	N	L	N	N	L	N	N	L	N	4.3	33
Ni(5)	10	100	30	15	50	30	7	70	30	2.7	88
Pb(10)	20	70	30	15	50	30	20	50	30	4.2	61
Sc(5)	7	20	15	5	15	10	10	20	15	2.5	25.6
Sn(10)	N	N	N	N	15	N	N	N	N	na	na
Sr(100)	N	100	L	N	100	L	L	100	L	10.4	1379
V(10)	70	150	100	50	150	70	70	100	100	12	261
Y(10)	20	70	30	15	50	20	20	100	30	8.3	69
Zn(5)	70	300	100	25	120	60	70	160	90	12.7	152
Zr(10)	500	>1000	700	150	700	500	300	>1000	1000	55	722

na-no data available
a/Hickling and others (1983).
b/Shacklette and others (1971).
c/About 95 percent of values reported fall between these ranges which include 2 geometric deviations on either side of the geometric mean.

The elemental values for the stream-sediment samples from the study areas may be compared with the elemental values given in column 4 of table 1 because stream sediments are derived from the soils which develop on local bed rock as well as from the mechanical break down of exposed bed rock and float blocks of detached bed rock. Consequently, if the elemental values reported for the stream-sediment samples from the study areas compare favorably with the normal distribution of those elements in surficial materials of the United States, it may be concluded that the stream sediments probably do not reflect the presence of unusual accumulations of valuable minerals at or near the surface in the study areas. The high and low values for the majority of the elements in columns 1 and 2 of table 1 compare favorably with those in column 4. Minor differences may be attributed to margins of error inherent in the analytical method employed as explained in table 1. The median values for boron in columns 1 and 2 are near the upper limits for boron in column 4. The high values for beryllium, manganese, nickel, lead, zinc, and zirconium in column 1, and tin in column 2 appear to be excessive when compared to the high values given in column 4. These high values can be explained as a result of weathering of the local bed rock and (or) as the result of human activities (agriculture, lumbering, and petroleum) in and around the study areas and do not indicate unusual accumulations of valuable metal or ore-bearing minerals.

The high median levels of boron in study area stream sediments (100 ppm median values in columns 1 and 2 versus a 100 ppm high value in column 4) may be attributed to high levels of boron in the bed rock as indicated by analyses of bedrock samples (table 2) discussed below. The stream sediments may be contaminated by detergents from the residences on the high ground surrounding the study areas (Plate 1). The high values for beryllium (5 ppm), nickel (100 ppm), and zinc (300 ppm) in column 1 are attributed to one sample HAF 008 (table 3). The rest of the values for these elements compare favorably with those in column 4. Sample HAF 008 also contains the highest value reported for cobalt (30 ppm). This sample was collected at the mouth of a small tributary (Plate 1) which drains an area of active oil-well drilling. High levels of these elements may represent contamination by fine metal particles and other oil-well drilling refuse. High levels of manganese (5,000 ppm) were found in six stream sediment samples (table 3). Median levels of manganese are not unusually high in the bedrock samples (table 2) although the 4 samples in table 5 exceed by as much as 7 times the average manganese values for these rocks. Manganese may concentrate in stream sediments in a relatively insoluble oxide form (Dorr and others, 1973, p. 388) and may be more abundant in stream sediments than in soils (column 4). The high value for lead in column 1, table 1, (70 ppm) was found in only one sample (HAF 013, table 3) and may be attributed to a pipeline that lies at the head of the drainage basin (Plate 1) above the sample locality. The high value for tin in column 2, table 1 was found in only one sample (HHC 009) and is probably attributable to contamination resulting from logging or oil and gas operations in the Hickory Creek track. It does not reflect tin mineralization in the area because tin was not detected in any other of the stream-sediment or bedrock samples.

Silver was detected in only one stream sediment sample (HAF 009, 0.7 ppm) and was not detected (lower limit of detection 0.5) in the bedrock samples from the study areas. Shacklette and others (1971) report no data for abundance of silver in surficial materials. The silver value in sample HAF 009 may represent contamination because neither the geology nor human activity (such as photographic processing) suggest a source for the silver.

Zirconium occurs in the heavy-mineral zircon, which is commonly present as a minor constituent of sandstone and siltstone (see table 2, column 6). Weathering releases zircon from bedrock and the zircon then becomes concentrated in stream sediments because of its toughness and density. This results in higher values for zirconium in stream sediments than is normally found in soils.

Table 2 summarizes the results of the bedrock sample analyses (columns 1, 3, and 4) for the study areas and includes a summary of the analytical results of bedrock samples from the Clarion River Roadless Area (column 5), for reasons discussed above. Averages for the global abundances of elements in shale (column 2) and sandstone (column 6) are given for comparison. Comparison of the results of the bedrock-sample analyses with these global averages serves the same purpose as described above for comparing the results of the stream-sediment analyses with the elemental composition of surficial materials in the United States.

The results of the shale and mudstone analyses are combined (table 2, column 1) and those for the sandstone and siltstone samples are combined (column 3) for the Allegheny Front tract because in each case the major mineralogies of the combined rock types are most compatible with one another. However, some samples described as either shale and mudstone or as sandstone and siltstone in table 5 may contain varying amounts of the other lithologies because most samples are composites of stratigraphic intervals (see for example the descriptions for samples HAF 205, p. 20; and HAF 209, -214, and -303, p. 21). Siltstone especially, because it is fine-grained, may contain abundant amounts of shale in its matrix. The effect of these mixtures is to influence the elemental composition of the sample in the direction of the minor constituent. For example, if a quartzose sandstone sample contains shale, the elemental composition of the sample will be higher than if the sample were taken from relatively pure quartzose sandstone. This can be seen by comparing column 3 with column 6 in table 2. In the Hickory Creek tract (column 4) only sandstone bedrock samples were collected.

Most of the median values of the elements found in the bedrock samples (table 2, columns 1, 3, and 4), are consistent with the global averages for their respective rock types (columns 1 versus 2, and 3 and 4 versus 6) in that they are either: 1) more or less equal as in the case of nickel or zinc in column 1 versus column 2, and vanadium or zirconium in column 4 versus column 6; 2) within the limits of error of the analytical method used as in the case of boron or manganese in column 1 versus column 2, and nickel in column 4 versus column 6; or 3) much lower than the global averages as in the case of silver or niobium in column 1 versus column 2, and lanthanum or molybdenum in columns 3 and 4 versus column 6. Several seemingly high median values in column 3 versus column 6 may be attributed to the inclusion of shale in some of the sandstone/siltstone samples resulting in higher levels of certain elements than others; this would not have been the case if the sandstone/siltstone samples had been free of shale as in the case of the sandstone samples from the

Table 2. Range and median values for 23 elements in sandstone, siltstone, and shale bedrock samples from in and near the Allegheny Front and Hickory Creek Roadless Areas, Warren County, Pennsylvania and the Clarion River Roadless Area, Elk County, Pennsylvania. All analyses are by semiquantitative spectrographic methods by B. M. Adrian, B. Zickmund, G. Nelson and D. McCullum, except zinc which are by atomic absorption by R. Fairfield. Spectrographic analyses are reported as six steps per order of magnitude (1, 1.5, 2, 3, 5, 7, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. The precision is shown to be within one adjoining interval on each side of the reported value 83 percent of the time and within two adjoining intervals on each side of the reported value 96 percent of the time (Motooka and Grimes, 1976). Letter symbols: L, detected but below limit of determination (value shown in parenthesis after element symbol); N, not detected; >, greater than. Elements analyzed for spectrographically but not detected and their lower limits of detection: As(200), Au(10), Bi(10), Cd(20), Sb(100), Sn(10), and W(50).

	1			2	3			4			5			6
	ALLEGHENY FRONT SHALE AND MUDSTONE 13 SAMPLES			AVERAGE IN SHALE a/	ALLEGHENY FRONT SANDSTONE AND SILTSTONE 18 SAMPLES			HICKORY CREEK SANDSTONE 6 SAMPLES			CLARION RIVER SANDSTONE AND SILTSTONE b/ 18 SAMPLES			AVERAGE IN SANDSTONE a,c/
Elements	LOW	HIGH	MEDIAN		LOW	HIGH	MEDIAN	LOW	HIGH	MEDIAN	LOW	HIGH	MEDIAN	
									PERCENT					
Ca(0.05)	L	2	0.07	2.21	L	5	0.05	L	L	L	L	0.07	0.05	3.9 a/
Fe(0.05)	5	10	7	4.72	1	10	5	0.3	1.5	0.3	N	10	3	0.98 a/
Mg(0.02)	0.7	1.5	1	1.5	0.02	1	0.7	0.02	0.03	0.02	0.03	1.5	0.5	0.7 a/
Ti(0.002)	0.5	0.7	0.5	0.46	0.05	0.7	0.5	0.15	0.5	0.3	0.07	1	1	0.15 c/
						PARTS PER MILLION								
Ag(0.5)	N	N	N	0.07	N	N	N	N	N	N	N	0.7	N	0.0X d/
B(10)	100	200	150	100	50	150	100	70	100	70	20	200	100	35 a/
Ba(20)	700	1500	1000	580	100	1000	500	70	200	150	100	1500	700	300 c/
Be(1)	1	3	1.5	3	N	3	1.5	N	N	N	N	3	1.5	2 c/
Co(5)	15	30	20	19	N	30	15	N	N	N	5	20	10	0.3 a/
Cr(10)	100	200	200	90	15	200	100	L	50	10	20	200	100	35 a/
Cu(5)	20	150	70	45	L	200	20	L	5	L	L	100	20	10-20 c/
La(20)	N	70	50	92	N	100	N	N	N	N	N	100	N	30 a/
Mn(10)	300	2000	1000	850	150	5000	700	L	1000	50	15	1000	300	500 c/
Mo(5)	N	5	N	2.6	N	7	N	N	N	N	N	20	N	0.2 a/
Nb(20)	N	L	L	11	N	L	N	N	N	N	N	20	N	0.0X d/
Ni(5)	30	70	50	68	5	70	30	5	5	5	L	70	30	2 a/
Pb(10)	15	1000	30	20	N	1500	20	N	N	N	N	50	20	9 c/
Sc(5)	20	50	20	13	N	30	10	N	N	N	N	50	20	1 a/
Sr(100)	N	150	100	300	N	200	100	N	N	N	N	100	N	35 c/
V(10)	100	200	150	130	15	200	100	20	30	20	10	300	150	20 a/
Y(10)	30	70	50	26	10	100	30	10	10	10	10	70	30	40 a/
Zn(5)	50	100	70	95	15	95	60	L	20	5	5	150	55	16 a/
Zr(10)	150	500	300	160	50	1000	500	50	700	200	50	>1000	300	220 a/

a/Turekian and Wedepohl (1961).
b/Hickling and others (1983).
c/Pettijohn (1963, p. S11).
d/Order of magnitude estimated by Turekian and Wedepohl (1961).

the Hickory Creek tract (column 4 versus column 6). Elements that are probably related to shale in the samples are barium, cobalt, chromium, nickel, lead, scandium, and vanadium, and possibly also boron, iron, strontium, and zinc. Siltstone samples have consistently higher median values for most elements than do the sandstone samples (see siltstone samples HAF 302 and -305 versus sandstone samples HAF 102 and -202, table 5) and sandstone or siltstone samples containing abundant shale or mudstone commonly have the highest elemental values as in the case of samples HAF 205 and -206 (table 5). High median values for yttrium and zirconium in column 1 may be attributed to sandstone and (or) siltstone that occur in many of the shale samples (HAF 210 and -307, table 5). In spite of these factors, some values in table 2 are higher than would be expected for normal distribution patterns in their respective rock types. These values are distributed as follows: 1) median values for barium and chromium and a very high value for lead in column 1; 2) the high values for calcium, iron, manganese, molybdenum, lead, and strontium in column 3; and 3) the median value for boron in column 4. These seemingly unusual elemental values require additional discussion, but the discussion will be brief because unusual concentrations of minerals that contain these elements were not found, nor have any been reported, in the study areas.

The shale samples containing the highest levels of barium are of Devonian age (see table 5, and sample descriptions, pp. 20 to 22). Isolated high levels of barium have been reported by J.F. Pepper (1964, USGS unpublished manuscript, Reston, VA) in Middle and Upper Devonian shales from New York to Virginia. High chromium values (column 1) appear to be restricted to the Venango Formation of the Upper Devonian Series and may reflect the erosion of chromium-rich rocks in the source area during Late Devonian time. The unusually high value of 1,000 ppm lead (column 1) occurs in only one sample (HAF 303); however, the median value for lead is well within the normal range for lead in shale (column 2). This anamolously high value is probably the result of contamination of the sample because only one sample contains such a high lead value and because the composition of the bed rock does not suggest lead enrichment. This same reasoning probably accounts for the very high lead level (1,500 ppm) in column 3, which also occurs in only one sample (HAF 214, table 5).

The high value for calcium in column 3 (sample HAF 308, table 5) may be attributed to calcareous fossils, and the high level of strontium, found in the same sample, is probably also attributable to the calcareous fossils because strontium is commonly associated with calcium. The large high value for manganese (5,000 ppm) in column 3 is present in one sample (HAF 204, table 5). Several large "high" values for manganese in columns 3 and 4 of table 2 (see also tables 5 and 6) may represent concentrations of the insoluble oxide form near outcropping bed rock surfaces. Molybdenum was found in only two samples from the study areas (HAF 303, column 1 and HAF 102, column 3). HAF 303 is a shale sample and the value for molybdenum (5 ppm) is not unusual for shale, but the value (7 ppm) in sample HAF 102, which is a sandstone/siltstone sample is far above average for a sandstone and sample contamination is suspected. The median levels for boron are high in all samples from the study areas and they are unusually high in the samples from the Hickory Creek tract (column 4). The Hickory Creek samples were collected from a relatively quartz-rich sandstone which should be low in boron (35 ppm, column 6). Boronbearing minerals may have been leached from overlying shale and redeposited in the sandstone by percolating groundwater, but more likely the high levels of boron indicate a provenance for the sediments which was rich in boron.

Summary

The geochemical data developed as the result of a reconnaissance survey of the Allegheny Front and Hickory Creek Roadless Areas do not contain any evidence of obviously anomalous chemical-element concentrations related to mineralized rock. Seemingly anomalous values of some elements may be explained as the result of local bedrock composition, normal geologic processes, and (or) human activities (agriculture, forestry, and petroleum) in and near the study areas.

Table 3.--Semiquantitative spectrographic analyses of 21 stream-sediment samples from in and near the Allegheny Front Roadless Area.[a] (Sample locations are shown on plate 1.)

Sample	X coordinate	Y coordinate	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Co-ppm s	Cr-ppm s
HAF001	640,660	4,622,980	2.0	.3	.07	.5	2,000	100	700	2.0	15	70
HAF002	639,700	4,621,120	3.0	.5	.10	.5	1,500	150	700	1.5	15	100
HAF003	639,910	4,621,620	3.0	.5	.20	.7	1,500	100	700	1.0	15	100
HAF004	642,970	4,629,180	2.0	.3	.10	.5	1,500	100	500	1.5	15	70
HAF005	645,090	4,631,170	3.0	.5	.07	.7	1,500	150	700	1.5	15	70
HAF006	645,020	4,631,130	5.0	.7	.20	.7	3,000	100	1,000	1.5	15	100
HAF007	644,180	4,626,560	3.0	.3	.07	.7	2,000	150	700	2.0	20	100
HAF008	644,340	4,626,370	2.0	.3	.10	.7	5,000	100	700	5.0	30	70
HAF009	644,710	4,625,670	3.0	.2	.05	.5	5,000	70	700	2.0	20	70
HAF010	644,660	4,625,630	1.5	.2	.05	.5	5,000	70	500	2.0	20	70
HAF011	644,200	4,628,960	3.0	.3	.05	.7	2,000	100	500	1.5	10	70
HAF012	644,220	4,629,090	5.0	.5	.15	.7	2,000	100	700	1.5	10	100
HAF013	643,790	4,629,190	3.0	.7	.20	.7	5,000	100	1,000	1.5	15	100
HAF014	643,000	4,627,090	2.0	.3	.05	.7	3,000	100	700	1.5	15	70
HAF015	642,980	4,627,170	5.0	.5	.20	.7	3,000	100	1,000	1.5	10	100
HAF016	642,400	4,624,850	1.5	.3	.07	.5	2,000	150	700	1.5	15	100
HAF017	642,720	4,624,160	2.0	.3	.10	.7	5,000	100	700	1.0	15	200
HAF018	642,780	4,624,210	3.0	.5	.07	.7	2,000	100	700	1.5	15	100
HAF019	641,880	4,623,600	1.5	.2	.05	.7	5,000	100	300	1.5	15	70
HAF020	641,100	4,622,020	3.0	.3	.07	.7	1,500	100	700	1.5	10	70
HAF021	641,200	4,622,060	2.0	.2	.05	.7	2,000	100	500	1.5	15	150

Sample	Cu-ppm s	La-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sc-ppm s	Sr-ppm s	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Zn-ppm aa
HAF001	15	N	<20	50	30	10	<100	70	30	N	500	120
HAF002	15	N	<20	20	30	15	<100	100	30	N	500	70
HAF003	20	N	N	30	50	20	100	150	50	N	700	85
HAF004	15	N	N	30	30	10	<100	100	30	N	700	100
HAF005	20	N	N	30	30	15	<100	100	70	N	700	100
HAF006	30	N	N	30	50	15	<100	150	50	N	500	100
HAF007	20	<20	<20	50	30	15	<100	100	30	N	700	110
HAF008	15	N	N	100	30	10	<100	100	30	300	700	300
HAF009	15	N	N	30	30	10	<100	100	50	N	1,000	150
HAF010	20	<20	N	20	50	10	<100	100	30	N	1,000	120
HAF011	15	70	N	50	20	15	<100	100	20	N	1,000	90
HAF012	30	50	N	50	30	20	<100	150	50	<200	500	75
HAF013	30	50	N	50	70	20	100	150	50	N	500	85
HAF014	15	N	N	30	20	10	N	70	30	N	>1,000	120
HAF015	30	N	N	70	50	15	<100	150	30	N	700	120
HAF016	20	N	N	30	30	10	<100	70	30	200	500	120
HAF017	20	N	N	30	50	10	<100	100	30	N	1,000	180
HAF018	20	N	N	20	30	15	<100	100	30	N	1,000	75
HAF019	15	N	N	10	30	7	<100	70	20	N	1,000	70
HAF020	15	N	N	30	20	15	<100	100	30	N	700	80
HAF021	10	N	N	20	20	10	<100	70	30	N	1,000	75

[a] See p. 15 for footnote.

Table 4.--Seimquantitative spectrographic analyses of 23 stream-sediment samples from in and near the Hickory Creek Roadless Area.[a] (Sample locations are shown on plate 1.)

Sample	X coordinate	Y coordinate	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Co-ppm s	Cr-ppm s
HHC001	637,300	4,616,740	3.0	.30	.05	.5	1,000	100	300	1.0	15	100
HHC002	635,630	4,615,530	5.0	.30	.07	.5	1,000	150	300	1.5	15	100
HHC003	639,140	4,620,190	3.0	.30	.07	.5	1,000	70	300	1.5	15	70
HHC004	637,270	4,618,440	3.0	.30	.07	.5	1,000	70	300	1.0	15	70
HHC005	643,910	4,618,080	1.5	.10	<.05	.3	1,500	100	200	1.5	15	50
HHC006	643,660	4,617,870	2.0	.15	<.05	.5	500	70	200	1.5	15	100
HHC007	642,620	4,618,290	2.0	.20	.07	.3	700	50	200	2.0	15	70
HHC008	636,900	4,611,510	3.0	.30	.05	.5	1,500	100	300	1.5	15	100
HHC009	639,300	4,612,430	2.0	.20	.05	.5	1,000	100	300	1.5	10	100
HHC010	642,630	4,614,320	2.0	.15	.05	.3	2,000	70	300	1.5	15	50
HHC011	641,350	4,614,090	3.0	.50	.07	.5	1,000	100	500	2.0	20	150
HHC012	640,340	4,613,230	2.0	.20	.05	.5	700	70	300	1.0	7	70
HHC013	640,260	4,613,250	2.0	.15	.05	.3	1,000	70	300	1.5	10	70
HHC014	640,340	4,612,840	5.0	.30	.10	.5	500	100	300	1.5	20	100
HHC015	640,390	4,617,040	3.0	.20	.05	.5	1,000	100	300	1.5	15	70
HHC016	640,640	4,616,920	2.0	.10	.05	.5	300	100	200	1.0	7	50
HHC017	640,080	4,614,000	2.0	.20	<.05	.3	700	70	200	1.0	10	70
HHC018	639,580	4,615,370	2.0	.20	.05	.5	1,000	100	300	1.0	15	100
HHC019	639,760	4,614,030	2.0	.15	<.05	.5	200	100	200	1.0	7	70
HHC020	638,460	4,611,820	2.0	.20	.05	.5	300	70	300	1.0	7	70
HHC021	645,510	4,614,370	3.0	.20	.05	.5	2,000	100	300	1.5	20	100
HHC022	645,640	4,614,160	3.0	.20	.05	.3	2,000	100	300	1.5	15	70
HHC023	644,980	4,614,250	3.0	.30	.05	.5	3,000	100	300	2.0	20	100

Sample	Cu-ppm s	La-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sc-ppm s	Sr-ppm s	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Zn-ppm aa
HHC001	15	N	<20	30	20	10	N	100	20	N	500	50
HHC002	20	N	N	30	50	15	100	100	20	N	500	--
HHC003	15	N	N	30	30	15	N	100	30	N	300	60
HHC004	15	N	N	30	30	15	<100	100	20	N	500	45
HHC005	7	N	N	15	15	5	<100	50	20	N	700	45
HHC006	10	N	N	20	20	10	N	70	20	N	500	50
HHC007	15	N	N	50	20	10	N	70	20	N	150	110
HHC008	15	N	N	30	30	15	<100	100	20	N	300	75
HHC009	15	N	N	30	50	7	<100	70	30	N	500	25
HHC010	10	N	N	50	20	7	N	70	15	N	300	80
HHC011	20	N	<20	50	50	15	100	150	50	N	300	70
HHC012	15	N	N	20	30	7	<100	70	20	N	500	60
HHC013	7	50	N	20	15	5	<100	50	20	N	500	70
HHC014	20	N	<20	30	50	15	<100	100	30	N	300	80
HHC015	15	N	N	30	30	10	<100	70	20	N	700	60
HHC016	7	N	N	20	15	5	<100	50	20	N	500	50
HHC017	10	N	N	20	15	7	<100	70	30	N	500	70
HHC018	15	N	N	30	30	10	<100	70	30	N	500	70
HHC019	7	N	N	20	15	7	<100	70	20	N	500	45
HHC020	15	N	N	20	30	10	<100	70	30	N	500	30
HHC021	10	N	N	30	20	10	<100	70	20	N	500	75
HHC022	15	N	N	30	20	10	<100	70	30	N	500	75
HHC023	20	N	N	30	50	10	<100	100	30	N	500	120

[a] See p. 15 for footnote.

Table 5.--Semiquantitative spectrographic analyses of 31 bedrock samples from in and near the Allegheny Front Roadless Area.[a/] (Sample locations are shown on plate 1.)

Sample	X coor-dinate	Y coor-dinate	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Co-ppm s	Cr-ppm s
HAF101[1]	640,790	4,623,050	10	1.50	.07	.50	700	200	1,000	3.0	20	200
HAF102[3]	640,800	4,623,050	2	.20	.05	.20	500	50	200	<1.0	10	30
HAF103[1]	640,770	4,623,050	7	1.50	.07	.50	1,000	150	1,000	3.0	20	200
HAF104[1]	640,760	4,623,040	7	1.00	.07	.50	1,500	150	1,000	3.0	30	200
HAF105[1]	640,750	4,623,030	10	1.50	.07	.50	1,500	150	1,500	3.0	30	200
HAF201[3]	639,400	4,619,970	3	.30	.05	.50	150	100	200	<1.0	7	70
HAF202[3]	639,410	4,619,960	5	.30	<.05	.50	300	70	200	<1.0	7	50
HAF203[2]	639,410	4,619,960	7	1.00	.07	.70	1,000	150	700	3.0	20	200
HAF204[3]	639,420	4,619,950	7	.70	3.00	.50	5,000	50	500	1.5	15	70
HAF205[3]	639,430	4,619,930	10	1.00	.07	.70	1,000	150	1,000	3.0	15	150
HAF206[3]	639,440	4,619,920	10	1.00	.07	.70	700	150	700	2.0	15	150
HAF207[3]	639,460	4,619,920	7	.70	.05	.70	700	100	500	2.0	15	100
HAF208[3]	639,480	4,619,920	10	.70	.50	.50	2,000	100	500	2.0	20	100
HAF209[1]	639,620	4,619,920	10	1.00	.10	.70	1,500	150	1,000	2.0	20	150
HAF210[1]	639,640	4,619,920	7	.70	.30	.50	1,000	100	700	1.5	20	150
HAF211[1]	639,660	4,619,920	5	.70	.07	.50	700	100	700	1.5	15	150
HAF212[1]	639,670	4,619,930	7	.70	.05	.50	500	150	700	2.0	15	150
HAF213[3]	639,750	4,619,970	3	.30	1.00	.30	1,500	50	300	<1.0	7	50
HAF214[2]	639,820	4,620,060	7	1.00	.05	.50	500	100	700	1.5	15	200
HAF215[3]	639,850	4,620,050	5	.30	.05	.50	700	100	300	1.0	10	100
HAF216[1]	639,890	4,620,130	10	.70	.05	.50	300	150	700	1.5	15	200
HAF217[3]	640,380	4,620,300	1	.20	<.05	.50	500	50	200	<1.0	7	100
HAF301[1]	644,240	4,633,350	5	1.00	2.00	.50	1,000	150	700	1.0	15	200
HAF302[2]	644,250	4,633,350	7	1.00	.20	.50	1,000	100	1,000	1.5	20	150
HAF303[1]	644,260	4,633,350	7	.70	.50	.70	700	100	1,500	1.0	30	100
HAF304[1]	644,270	4,633,360	10	1.00	.05	.70	500	100	1,000	1.5	20	200
HAF305[2]	644,280	4,633,360	5	1.00	.07	.70	500	150	700	1.5	30	150
HAF306[2]	644,290	4,633,370	7	.70	.05	.50	300	100	500	1.0	15	100
HAF307[1]	644,280	4,633,380	10	1.00	1.50	.50	2,000	100	1,000	1.5	15	150
HAF308[3]	644,290	4,633,390	2	.30	5.00	.20	3,000	50	200	<1.0	10	50
HAF401[3]	644,420	4,624,850	1	.02	.05	.05	300	70	100	N	N	15

[1] Shale

[2] Siltstone

[3] Sandstone

[a/] See p. 15 for footnote

Table 5.--Continued (Allegheny Front bedrock samples)

Sample	Cu-ppm s	La-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sc-ppm s	Sr-ppm s	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Zn-ppm aa
HAF101 [1]	100	N	<20	70	30	30	100	150	30	<200	150	70
HAF102 [3]	10	N	N	20	20	10	N	50	15	<200	150	95
HAF103 [1]	70	50	<20	50	50	30	150	150	50	200	150	80
HAF104 [1]	70	50	<20	70	50	50	150	200	50	200	150	80
HAF105 [1]	100	50	<20	70	50	50	150	200	50	200	150	100
HAF201 [3]	10	N	N	20	10	10	N	70	20	N	500	35
HAF202 [3]	10	N	N	20	10	10	N	70	30	N	500	35
HAF203 [2]	50	50	<20	50	30	30	100	150	50	N	500	65
HAF204 [3]	70	50	N	30	20	15	100	100	50	N	500	60
HAF205 [3]	70	50	<20	70	20	30	100	200	50	N	500	80
HAF206 [3]	70	50	<20	70	20	30	100	150	50	N	300	65
HAF207 [3]	20	50	<20	50	15	20	100	100	30	N	500	60
HAF208 [3]	30	100	N	70	20	20	100	200	100	N	500	75
HAF209 [1]	100	50	<20	70	50	30	100	200	50	N	300	75
HAF210 [1]	70	50	<20	50	20	20	<100	100	70	N	500	70
HAF211 [1]	70	50	<20	30	20	20	<100	100	50	N	500	55
HAF212 [1]	70	50	<20	50	20	20	<100	150	50	N	500	65
HAF213 [3]	5	N	N	20	50	7	100	50	20	N	200	50
HAF214 [2]	50	N	<20	70	1,500	20	<100	150	30	N	300	60
HAF215 [3]	15	N	N	30	50	10	<100	100	30	N	700	30
HAF216 [1]	70	<20	<20	70	20	20	N	200	50	N	500	50
HAF217 [3]	7	N	N	10	10	5	N	50	20	N	500	30
HAF301 [1]	20	50	<20	30	20	20	150	100	50	N	500	55
HAF302 [2]	50	N	N	50	50	20	100	150	30	N	300	60
HAF303 [1]	70	N	<20	70	1,000	20	100	100	50	N	300	70
HAF304 [1]	70	N	<20	50	30	30	100	200	30	N	200	80
HAF305 [2]	15	N	<20	50	30	30	100	200	50	N	300	60
HAF306 [2]	200	N	<20	30	10	15	100	100	50	N	1,000	55
HAF307 [1]	150	70	N	30	15	20	100	100	70	N	500	50
HAF308 [3]	5	N	N	20	70	10	200	70	15	N	200	20
HAF401 [3]	<5	N	N	5	N	N	N	15	10	N	50	15

[1] Shale

[2] Siltstone

[3] Sandstone

Table 6.--Semiquantitative spectrographic analyses of 6 sandstone bedrock samples from in and near the Hickory Creek Roadless Area.[a] (Sample locations are shown on plate 1.)

Sample	X coor-dinate	Y coor-dinate	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Co-ppm s	Cr-ppm s
HHC101	643,590	4,618,720	.3	.02	<.05	.30	<10	100	150	N	N	<10
HHC102	643,580	4,618,720	.3	.02	<.05	.15	50	100	70	N	N	<10
HHC103	643,570	4,618,730	1.0	.02	<.05	.15	10	70	100	N	N	10
HHC104	643,560	4,618,750	.3	.02	<.05	.20	50	70	70	N	N	10
HHC105	643,560	4,618,770	.5	.03	<.05	.50	1,000	70	200	N	N	30
HHC106	643,550	4,618,790	1.5	.03	<.05	.30	500	100	150	N	N	50

Sample	Cu-ppm s	La-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sc-ppm s	Sr-ppm s	V-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Zn-ppm aa
HHC101	<5	N	N	5	N	N	N	20	10	N	300	5
HHC102	<5	N	N	5	N	N	N	20	10	N	200	5
HHC103	<5	N	N	5	N	N	N	30	10	N	100	15
HHC104	<5	N	N	5	N	N	N	20	10	N	50	5
HHC105	<5	N	N	5	N	N	N	30	10	N	500	<5
HHC106	5	N	N	5	N	N	N	30	10	N	700	20

[a] See p. 15 for footnote.

a/Footnote to tables 3-6. (Semiquantitative spectrographic analyses of stream-sediment and bedrock samples, Allegheny Front and Hickory Creek Roadless Areas.)

The X and Y coordinates are Universal Transverse Mercator (UTM) grid values, zone 16. The X-coordinate is the easting value; the Y is the northing. Spectrographic analyses are reported as six steps per order of magnitude (1, 1.5, 2, 3, 5, 7, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. The precision is shown to be within one adjoining interval on each side of the reported value 83 percent of the time and within two adjoining intervals on each side of the reported value 96 percent of the time (Motooka and Grimes, 1976). Symbols used include S, semiquantitative spectrographic analysis; <, less than lower limit of determination; >, greater than upper limit of determination; aa, atomic-absorption determination; N, not detected. The limits apply under ideal conditions, and in some cases interferences will narrow the limits. All data are in parts per million (ppm) except where indicated in percent (pct.). Elements looked for spectrographically but not found and their lower limit of detection: Ag(0.5), except HAF 009, 0.7 ppm; As(200); Au(10); Bi(10); Cd(20); Mo(5), except HAF 102, 7 ppm, HAF 303, 5 ppm, and HAF 305, <5 ppm; Sb(100); Sn(10), except HHC 009, 15 ppm; Th(100); and W(50).

Description of Bedrock Samples

Allegheny Front Roadless Area

Sample No. (Locations of samples are shown on Plate 1)

Venango Formation

HAF 101 Shale, light- to medium-olive-gray, weathers light olive tan, silty. Channel sample, 5.4 ft.

HAF 102 Sandstone, light- to medium-gray, weathers light grayish brown, very fine to fine-grained, scattered opaque minerals and scattered mica. Composite of chip samples, 2.9 ft.

HAF 103 Shale, light- to medium-gray. Channel sample, 6.0 ft.

HAF 104 Shale, dark-gray to black. Channel sample, 6.0 ft.

HAF 105 Shale, medium-gray. Channel sample, 6.0 ft.

HAF 201-217 were collected along the Bully Hollow Road section (Schweinfurth and others, 1982c, p. 11-16).
Each sample is a composite of chip samples taken over an interval of 5.4 ft.

Venango Formation

HAF 201 Sandstone, weathers mottled brown and olive, very fine grained, thin-bedded.

HAF 202 As above.

HAF 203 Sandstone and interbedded mudstone, medium-brown, thin- to very thin bedded, ripple-bedded, clay pebbles.

HAF 204 Sandstone, weathers mottled brown and olive, very fine grained, thin-bedded.

HAF 205 Sandstone, medium- to dark-brownish-gray, very fine grained, interbeds of mudstone and siltstone in thin- to very thin beds, ripple-bedded.

HAF 206 As above.

HAF 207 Sandstone, weathers grayish brown to medium olive gray, very fine grained, interbeds of very thin bedded siltstone.

HAF 208 Sandstone, weathers mottled grayish brown to medium olive gray, very fine grained, low angle cross bedding.

Sample No.

Oswayo-Cuyahoga Formations, undivided

HAF 209 Shale, weathers medium olive gray, blocky, contains a few thin interbeds of siltstone and very fine grained sandstone.

HAF 210 As above.

HAF 211 As above.

HAF 212 As above with 50 percent siltstone interbeds.

HAF 213 Sandstone, weathers grayish brown to medium olive gray, very fine grained, thin-bedded.

HAF 214 Siltstone, grayish-olive, contains interbeds of shale in lower half.

HAF 215 Sandstone, weathers grayish brown to medium olive gray, very fine grained, silty, thin-bedded.

HAF 216 Mudstone, medium-olive-brown, weathers tan, argillaceous.

HAF 217 Sandstone, weathers grayish buff to grayish tan, fine-grained, quartzose.

HAF 301-308 were collected along the Youngsville section (Schweinfurth and others, 1982c, p. 4-9). Each sample is a composite of chip samples taken over an interval of 5.4 ft.

Venango Formation

HAF 301 Shale, medium-gray, some discoidal shaped siderite (?) concretions.

HAF 302 Siltstone, medium-gray, very hard, thin- to medium-bedded.

HAF 303 Shale, medium-gray, siliceous, contains a few very thin beds of siltstone.

HAF 304 Shale, dark-brownish-maroon, slightly siliceous.

HAF 305 Siltstone, weathers grayish light brown to light olive gray, contains carbonized plant fragments.

HAF 306 Siltstone, grayish-maroon mottled with light-olive-gray.

HAF 307 Shale, maroon, with interbeds of maroon mudstone and siltstone.

HAF 308 Sandstone, light-greenish-gray, very fine grained, thin- to medium-, and irregularly-bedded, quartzose, abundant borings.

Sample No.

Olean Formation

HAF 401 Sandstone, light-buff, medium- to very coarse grained, conglomeratic with quartz pebbles as much as 3/8" in diameter, few opaque minerals, some iron staining. Composite of chip samples 8.0 ft.

Hickory Creek Roadless Area

Olean Formation

Each sample is a composite of chip samples taken over an interval of 5.4 ft.

HHC 101 Sandstone, light-buff, weathers light to medium gray, fine-grained, quartzose, contains scattered opaque minerals.

HHC 102 Sandstone, white, weathers gray, fine- to medium-grained, quartzose, contains scattered opaque minerals.

HHC 103 Sandstone, tan to tanish-white, fine- to medium-grained, iron stained along fractures, quartzose, contains scattered opaque minerals.

HHC 104 Sandstone, light-gray to grayish-white, weathers medium gray, fine- to medium-grained, quartzose, contains scattered opaque minerals.

HHC 105 As above.

HHC 106 Sandstone, light-gray to grayish-white, very fine to medium-grained, iron staining along fractures.

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